Midpoint Project Status Report for Geiger Field Installation

Proton Exchange Membrane (PEM) Fuel Cell Demonstration of Domestically Produced Residential PEM Fuel Cells in Military Facilities

242nd Combat Communications Squadron, Geiger Field, WA

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Introduction

Background

The Construction Engineering Research Laboratory (CERL) is a division of the U.S Army Engineer Research and Development Center. CERL's mission is to assist the military in addressing existing needs, directing research, and developing products utilizing experimental technologies. The Residential Fuel Cell Program is intended to advance the development of PEM fuel cells and promote their penetration into the marketplace by providing long-term test data to Department of Defense personnel as well as fuel cell manufacturers.

The Avista Labs SR-72 modular Proton Exchange Membrane (PEM) fuel cell is a 3kW fuel cell utilizing Avista Labs' modular cartridge approach to PEM fuel cells. The scope of this project was to install an SR-72 at the Geiger Field, 242nd Combat Communications Squadron's building 401. The fuel cell was to power lighting at the installation as well as large bay doors and the building's LAN switch. The SR-72 has been installed in building 401 and is powering the specified equipment.

This report details the site preparation and installation of the Avista Labs SR-72 fuel cell at Geiger Field.

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Installation Process

The 242 Combat Communications Squadron is a division of the Washington State Air National Guard. The squadron is located in Spokane, Washington at the south end of Spokane International Airport. The fuel cell was to be located in Building 401 of the Power Production Group of the 242nd. Building 401 serves as a maintenance shop for Air National Guard air conditioners and generators. The ground breaking, construction, and installation all took place while Guard personnel were on site, approximately 40 hours per week.

Site Selection

Site selection began in July 2001. Discussions with the Air National Guard resulted in selection of the Geiger Field facility. The Air National Guard recommended powering a load in building 401, their generator maintenance facility. A tour of the facility resulted in the decision to power a portion of the garage bay lighting, the building LAN switch, and garage bay doors. The lighting load would provide a constant load (approximately 1.7 kW) for 10 hours a day, 4 days a week while personnel were on site. The large bay doors would provide a transient load at various times throughout the day. Powering the building's LAN switch would illustrate the role of PEM fuel cells as a reliable power source for mission critical equipment.

The bid for this project was awarded on October 4, 2001. Following this, Air Force personnel were contacted to obtain approval and establish chains of communication. Dr. Binder visited the site December 17, 2001 for the project kickoff. Design then commenced on the project. The design was completed in mid January and the project was placed on hold pending approval from the Air Force and Air National Guard personnel. Both agencies approved the design and construction began in late January.

Site Layout

Figure 1 details the location of the fuel cell and the associated hydrogen fuel supply. The fuel cell is located in Building 401, Figure 1. The hydrogen supply (H2 STG., Figure 1) for the fuel cell is located on the north side of Bldg. 401, 50 feet from the building.

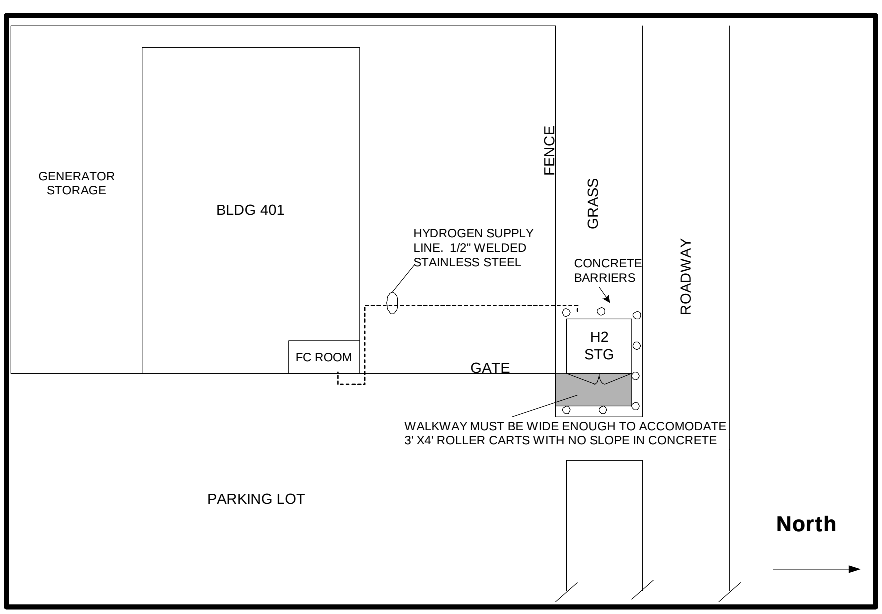

Figure 1

Room Layout

The fuel cell is located in building 401. A storage closet was modified to serve as the fuel cell room. The fuel cell, a data-logging computer with associated sensors, power transfer equipment, and safety sensors were installed in the room. The data-logging computer and sensors are connected to the fuel cell for continuous monitoring and logging of data. The data-logging computer has access to an analog phone line. Test data is transferred to Avista Labs on a daily basis via a dial up modem.

Room Preparation

The fuel cell room previously served as a storage closet, a telecom room, and a compressor room. This room was renovated for the fuel cell installation. The compressor, the sink, and the air heater (Figure 3) were removed and the room refinished (Figure 4).

Figure 4

Figure 3

Room Electrical

Once the equipment was removed from the fuel cell room and the room refinished, electrical modifications were made to the room. A disconnect switch, automatic transfer switch, distribution panel and UPS were all added to the room. The electrical one line is shown in Figure 5. The electrical work for the room, rewiring of the electrical circuits to be powered from the fuel cell, and the installation of the alarm systems was completed the latter part of February. Upon completion of the electrical work, the safety system was inspected and final approval was given on March 5, 2001. The fuel cell was installed on March 6, 2001.

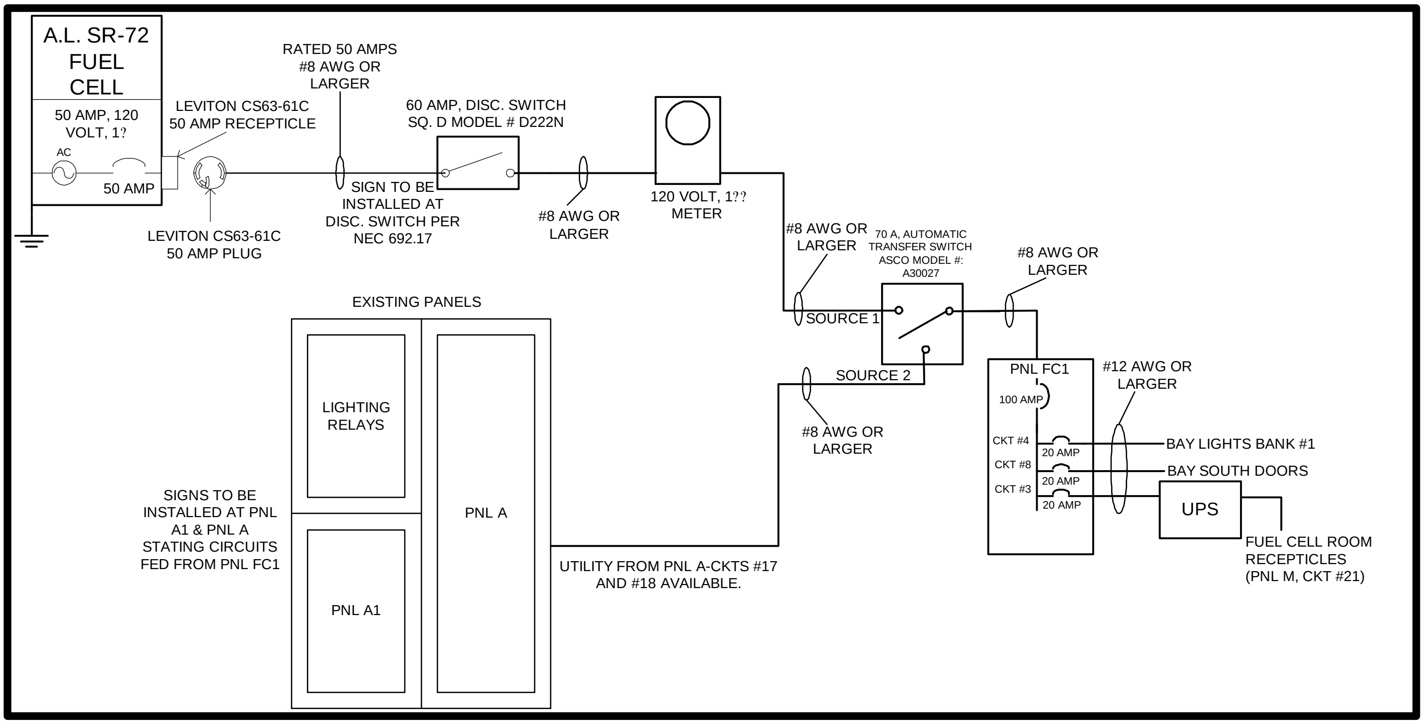
A.L. SR-72 FUEL CELL
50 AMP, 120 VOLT, 1?
AC
50 AMP
LEVITON CS63-61C 50 AMP RECEPTICLE
LEVITON CS63-61C 50 AMP PLUG
RATED 50 AMPS #8 AWG OR LARGER
SIGN TO BE INSTALLED AT DISC. SWITCH PER NEC 692.17
60 AMP, DISC. SWITCH SQ. D MODEL # D222N
#8 AWG OR LARGER
120 VOLT, 1??
METER
#8 AWG OR LARGER
70 A, AUTOMATIC TRANSFER SWITCH ASCO MODEL #: A30027
SOURCE 1
SOURCE 2
#8 AWG OR LARGER
#8 AWG OR LARGER
PNL FC1
100 AMP
#12 AWG OR LARGER
CKT #4
CKT #8
CKT #3
20 AMP
20 AMP
20 AMP
BAY LIGHTS BANK #1
BAY SOUTH DOORS
UPS
FUEL CELL ROOM RECEPTICLES (PNL M, CKT #21)
EXISTING PANELS
LIGHTING RELAYS
PNL A
PNL A1
SIGNS TO BE INSTALLED AT PNL A1 & PNL A STATING CIRCUITS FED FROM PNL FC1
UTILITY FROM PNL A-CKTS #17 AND #18 AVAILABLE.

Figure 5

Hydrogen Distribution and Storage

Hydrogen Storage Shed

The hydrogen is housed in an open-air storage shed with chain link walls and a tin roof. An open-air structure was preferable to inhibit hydrogen buildup in the event of a leak. The site for the shelter was determined from NFPA 50A "Standard for Gaseous Hydrogen Systems at Consumer Sites", as well as input from 242nd and Air Force personnel. The shelter is located approximately 50 feet to the north of building 401, Figure 6. To limit access to the hydrogen, the shed doors are locked. Construction on the hydrogen storage shed began in January. Figure 7 shows the concrete pad and frame for the shelter. The shelter was completed by the end of January. The completed shelter measures 10 feet by 12 feet and utilizes aluminum slats to limit visibility, Figure 8. Protecting the shelter are 3-foot high concrete piers spaced 4 feet apart. The shelter houses 4 hydrogen storage cradles. Each cradle consists of 12 Large, 261 CUF compressed hydrogen cylinders.

Figure 6

Figure 7

Figure 8

Hydrogen System Piping

There are 4 cradles of hydrogen housed in the hydrogen shelter. The hydrogen supplies are bussed together to provide 2 separate supplies of hydrogen consisting of 2 cradles. Each of these supplies is fed into the Avista Lab J-40 hydrogen supply module. The J-40 regulates high pressure hydrogen to a distribution pressure (15 - 30 psi). It provides an automatic switchover regulator to allow transfer from one hydrogen supply to the other when a supply drops below 200psi. Additionally, the J-40 incorporates several safety features advised for the distribution of hydrogen including a velocity fuse, flashback arrestor, filter, check valve, and redundant safety solenoids. The 350 CGA fitting on the output of the J-40 is connected to ½" stainless steel piping. The piping is buried at a depth of 18 inches and runs from the J-40 to the wall of building 401, Figure 9. In line with the hydrogen piping is a fireman's shutoff valve located prior to entering building 401. Upon entering building 401 a manual shutoff valve and a low-pressure regulator are installed prior to connecting to the SR-72 hydrogen manifold. The bleed line from the SR-72 is vented to the outside of the building using 3/16" stainless steel piping.

Figure 9

Hydrogen Supply Safety System

The hydrogen supply system incorporates several safety features. In addition to the J-40 hydrogen supply module safety features, the fuel cell room utilizes a hydrogen sensor, a heat detector and an air flow velocity switch. The alarm contacts of these sensors are wired in series with the power supply to the hydrogen supply solenoids housed in the J-40 hydrogen supply module. An alarm condition or loss of power in any of these sensors will result in a loss of power to the hydrogen supply system shutting it down. Before hydrogen flow can be re-activated, the alarm condition must clear, and an operator must manually re-energize the system.

Fuel Cell Installation

Install

The fuel cell was transported to building 401 on March 6, 2002. The fuel cell was constructed on site that same day and connected to the system. The SR-72 was providing power to the facility that afternoon.

The fuel cell was monitored for several days. Fluctuations in the hydrogen flow requirements of the fuel cell necessitated change out of the low-pressure regulator in favor of a higher volume low-pressure regulator. An additional, modification that had to be made was the addition of an exhaust system to the output vents of the SR-72. The SR-72's exhaust is warm humidified air. Size constraints of the fuel cell room required the fuel cell be installed 8 inches from a wall. This resulted in a large amount of input air being taken from the exhaust stream. The system began to overheat reducing the amount of fuel cell power being produced. The exhaust vents of the 6 SR-12s compising the SR-72 were connected in series and ducted into the existing room air exhaust ductwork, Figures 9 and 10. This resulted in a significant decrease in room air temperature and mixing of the input and exhaust air streams, and a return to rated SR-72 power output.

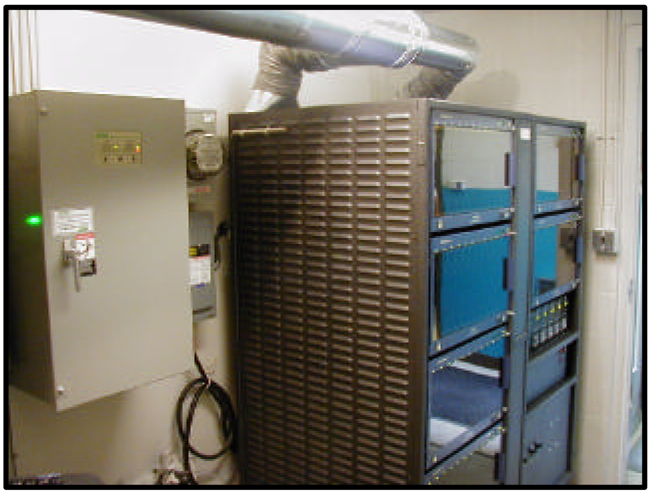

Figure 9

Figure 10

05/01/03

Acceptance Test

The acceptance test was performed with a Fluke 41 power meter. Harmonic measurements were taken after installation and found to be well within the required readings. Harmonics measured up to the 11th order are shown below in Table 1. The total harmonic distortion is less than 0.6% of the fundamental frequency. Also shown in the table is a summary of the data collected.

Table 1: THD

Readings - 04/12/02 14:43:05

Harmonics	Freq.	V Mag	%V RMS	V Ø°	I Mag	%I RMS	I Ø°	Power (kW)
DC	0.0	0.5	0.4	0	0.4	1.9	0	0.00
1	60.0	119.2	100.0	0	18.9	99.4	-8	2.24
2	119.9	0.1	0.1	-142	0.1	0.5	41	0.00
3	179.9	0.5	0.4	84	1.8	9.6	-63	0.00
4	239.8	0.0	0.0	-49	0.0	0.2	-66	0.00
5	299.8	0.3	0.3	96	1.0	5.1	-76	0.00
6	359.8	0.1	0.1	50	0.0	0.2	9	0.00
7	419.7	0.1	0.1	93	0.2	1.2	-64	0.00
8	479.7	0.0	0.0	72	0.0	0.1	26	0.00
9	539.7	0.0	0.0	-18	0.2	1.1	20	0.00
10	599.6	0.0	0.0	142	0.0	0.2	-105	0.00
11	659.6	0.1	0.1	-36	0.1	0.3	-162	0.00

Readings - 04/12/02 14:43:05

Summary Information			Voltage	Current
Frequency	60.0	RMS	119.2	19.1
Power		Peak	168.3	25.9
kW	2.23	DC Offset	-0.5	-0.4
KVA	2.27	Crest	1.41	1.36
KVAR	0.30	THD Rms	0.6	11.1
Peak kW	4.45	THD Fund	0.6	11.2
Phase	8° lag	HRMS	0.7	2.1
Total PF	0.98	Kfactor	1.2	
DPF	0.99			

Performance Data:

A	B	C	D	E	F	G	H	
Site Name	Commissio n Date	Total Run time (Hours)	Time In Period (Hours)	Availability (%)	Total energy Produced (kWe-hrs AC)	Average Output (kW)	Capacity Factor (%)	Tot Us
Input	*Input*	*Input*		**1*	*Input*	**2*	**3*	
Geiger Field	**3/29/02**	**1204.00**	**1317.00**	**91.42**	**1142.00**	**0.87**	**28.9**	[illegible]

***1=> Availability = "C" / "D"**
***2=> Average Output (kW) = "F" / "C"**
***3=> Capacity Factor = "G" / (Fuel Cell Rating)**
***4=> Electrical Efficiency = ("F" / ("I" * 0.0787kWh/CUF Hydrogen)) * 100**
***5=> Total Efficiency = Electrical Efficiency (SR-72 Not a Cogeneration Unit)**
*** Data taken from 3/29/02 to 5/23/02**